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PUSH / PULL



**Everyone says it. Most of us have ordered it.
Few of us can explain it. 🤔**

**So: here's the physiology and
what the evidence actually says.**

**It's not a myth.
It's just widely misunderstood. 🍿**

ALBUMIN x LASIX **The *REAL* Story**

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THE CLASSIC PITCH

THE STORY WE ALL LEARNED 📖

- 1 Patient is puffy everywhere
but dry inside the vessels 🧯
- 2 Lasix alone → BP tanks
(nothing in the tank to filter)
- 3 So give albumin first → "pulls"
interstitial fluid back into the vessels
- 4 Then Lasix → kidneys have something
to work with → pee without crashing 🎯

A lovely story! One problem:

**It's built on a physiology model
from 1896.**

**And that model got a
major update. 🏠**

PMID: 20200043 · 22290457
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REVISED STARLING

IT DOESN'T SUCK

Classic Starling:

fluid leaks out the arterial end,
gets sucked back in the venous end.

A tidy little U-turn. 

Revised Starling (2010):

there is no meaningful "suck-back"
at the venous end in most tissues.
Fluid filters OUT along the whole capillary
and basically keeps going. 

So what brings fluid back into the
vasculature?

Not oncotic reabsorption.

The lymphatics. 

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THE GLYCOCALYX: THE BOUNCER 🚪

The glycocalyx is a fuzzy gel lining every capillary. Think of it as the bouncer at the vessel door. 🧑

It creates a tiny protein-free zone right underneath itself.

The oncotic gradient that actually matters isn't plasma vs. interstitium. It's plasma vs. that little space under the glycocalyx. 🤯

Translation:

pouring albumin into the plasma doesn't move fluid the way we were taught.

The glycocalyx decides.

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MEET YOUR LYMPHATICS

THE UNSUNG CIRCULATORY HERO

The real drainage system for tissue fluid
isn't the veins.

It's the lymphatics. 

 Tiny initial lymphatics open like flap valves
when tissue pressure rises.

 Bigger collecting lymphatics squeeze
rhythmically to pump lymph forward.

The thoracic duct dumps ~2–4 L/day
back into the great veins in the neck.

Here's the kicker: in heart failure, high venous
pressure “clogs” the lymphatic outlet.

It's like the drain works fine, but the sink
it empties into is already overflowing. 

Edema = the lymphatics got overwhelmed.
It's not just "low albumin." 

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SO WHY DOES 25% ALBUMIN WORK AT ALL? 🤔

**If albumin doesn't "pull," why does 25% albumin
expand plasma volume by
~twice what you infuse?**

Because it turns down the faucet
while the drain keeps running. 🚰

- 1 25% albumin raises oncotic pressure →
less fluid filters OUT of the vessels
- 2 Meanwhile the lymphatics
keep draining the interstitium
- 3 Less coming in, same going out →
the swollen tissue slowly dries out 📉

It's not suction. It's plumbing.

**The interstitium dehydrates
because you slowed down the faucet,
not because albumin soaked up the water. 🧽**

5% vs 25%:

KNOW YOUR BOTTLES

25% (hyperoncotic) = the push/pull bottle.

→ ~5× the oncotic pull of plasma;

100 mL expands volume 350–500 mL

→ Recruits interstitial fluid via lymphatics →
dehydrates the swollen tissue

→ This is the one for "dry inside, soaked outside" 

**5% (iso-oncotic) = a volume expander,
not a dehydrator.**

→ Roughly fills the tank 1:1;

doesn't pull from the interstitium

→ Its best-evidence home is cirrhosis:

large-volume paracentesis, SBP,

and hepatorenal syndrome 

Bottom line: for push/pull you want 25%.

**Reaching for 5% here is filling the bathtub
when you meant to drain it. **

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FUROSEMIDE

THE LASIX FINE PRINT

Furosemide is >90% bound to albumin
and hitches a ride to the kidney,
where it's secreted into the tubule
(not filtered).

In severe hypoalbuminemia (<2 g/dL):
less drug gets delivered to the pump,
so less natriuresis. 

BUT!!!! –

the JACC diuretic review is blunt about this:
as long as albumin is >2 g/dL,
there's little evidence that adding
albumin boosts furosemide's power
through pharmacokinetics.

**So the "albumin as an Uber for furosemide"
theory only really applies at the low end.** 

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OKAY BUT DOES IT WORK?

THE EVIDENCE

Meta-analysis

(Lee 2021, 13 studies, 422 pts):

albumin + furosemide beat furosemide alone
by **+31.45 mL/hr urine**
and **+1.76 mEq/hr sodium**.

The catch: it only really showed up when

- ☒ Albumin <2.5 g/dL
- ☒ Dose >30 g
- ☒ Cr >1.2 / eGFR <60
- ☒ Within the first 12 hours

Real effect.

Modest effect.

Very specific patient. 

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BIPPITY BOPPITY BOO

THE CINDERELLA PROBLEM

The effect doesn't stay for the whole ball.

Kitsios meta-analysis (10 studies):

 At 8 hours: +231 mL more urine

 At 24 hours: difference gone 

Makes sense –

albumin's plasma half-life is only 6–10 hours,
and in critically ill patients with a beat-up
glycocalyx, it leaks out even faster.

Practical rule:

**if you're doing this, give the Lasix
within 30–60 min of the albumin.**

**Don't order them 6 hours apart
and expect magic.** 

PMID: 24268626 · 41877204

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SEPSIS

THERE HAD TO BE A PLOT TWIST 

In sepsis, enzymes and inflammation
shred the glycocalyx.

Now:

- 🔴 Capillaries leak like a sieve
- 🔴 Albumin walks right into the interstitium
- 🔴 The oncotic gradient collapses.
Albumin's on both sides now

Pour in more albumin during a full-blown leak
and a lot of it just becomes
very expensive interstitial fluid. 💰

Some nuance: albumin may also help protect the
remaining glycocalyx (via sphingosine-1-phosphate).

**One MIMIC-IV cohort even found lower in-hospital
mortality with albumin + loop diuretic in septic
hypoalbuminemia (25.5% vs 36.5%).
Hypothesis-generating, not gospel.**

Timing and phase of illness matter. ⚖️

PMID: 30654825 · 41877204 · 40311834

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BEHOLD

THE BEST EVIDENCE YET

Chalikias 2026 –

the first proper RCT aimed at the right population:

 241 patients, ADHF + hepatic dysfunction

 Albumin + furosemide vs.
furosemide alone × 72h

Results:

- ✓ Better symptom relief ($P < .001$)
- ✓ Less worsening renal function (25% vs 38%)
- ✓ Smaller creatinine bump (0.07 vs 0.18 mg/dL)
- ✓ 1 day shorter stay

Why this group?

**Bad albumin synthesis + venous congestion
+ albumin often < 2.5 .**

**Every arrow of the physiology
points the same way. **

PMID: 42413681
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RESPIRATORY FAILURE

THE VENTILATED PATIENT 🫁

Itagaki 2022 –

meta-analysis of RCTs in ventilated,
hypoalbuminemic patients:

📈 **Oxygenation (P/F) improvement:**
RR 2.83.

Nearly 3× more likely to get better.

📉 Fewer hypotensive episodes

❌ No mortality benefit

High venous pressure chokes
the lymphatics in the lungs.

**Dehydrating the pulmonary interstitium
= better gas exchange.**

**So the O2 win makes physiologic sense —
just don't sell it as a survival drug. 🫁**

PMID: 36123902
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AT THE BEDSIDE EYEBALLS PLEASE. THIS MATTERS 🛑

**The best push/pull is the flood
you never let happen.**

If your fluid resuscitation is **targeted**, a la:
give fluid only to the responsive
AND tolerant patient,
and reach for pressors or inotropes when the heart
says yes but the veins say no
(remember my VExUS post?)
you create far fewer edematous,
intravascularly dry patients to rescue. 🎯

Push/pull is a repair tool, not a lifestyle.

It's for the patient who's already congested and
diuretic-resistant, not a green light to over-fill and
mop up later.

**Don't drown the interstitium during
resuscitations and you'll have reach for the
25% albumin a lot less. 🔧**

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A TOOL IS A TOOL

WHEN TO REACH FOR IT

Reasonable:

 **Albumin <2.5 g/dL** –

the star subgroup in every meta-analysis

 **ADHF** with

hepatic dysfunction / cardiorenal congestion

 **Diuretic resistance** after you've

maxed the loop dose + added a thiazide

 **Ventilated patient** where you're

fighting for the P/F ratio

Probably a waste:

 **Active sepsis** with brisk capillary leak
(it just leaks out)

 **Albumin >2.5 g/dL** (minimal PK payoff)

 **Under-dosing** (<30 g won't do it)

 **Nephrotic syndrome**

(they'll pee the albumin out)

 As a substitute for **fixing WHY they're congested**

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CHEAT SHEET

FROM ME TO YOU

Does it work?

Modest, real benefit in the right patient.
Not a myth, not a miracle.

Best candidate: albumin <2.5 g/dL
+ diuretic resistance + intact glycocalyx.

Which bottle: 25% for push/pull.
Save 5% for cirrhosis (LVP, SBP, HRS).

How much: 25–50 g
(>30 g is where benefit showed up).

Timing: Lasix within 30–60 min of the albumin.

Shelf life: ~6–10 h. Often gone by 24 h.

Who actually drains the swelling:
the lymphatics, not oncotic suck-back (ew).

**Best strategy of all: targeted resuscitation up front
so you rarely need the rescue. 🎯**

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Push/pull isn't a myth. It's a misunderstood mechanism.

**The lymphatics do the draining.
The glycocalyx decides whether
your albumin stays put.**

**And the evidence says:
albumin <2.5, dose >30 g, use 25%,
give the Lasix right after,
and keep your expectations calibrated.**

Save 📌 for future you

**Share 📤 with your friend who still
thinks albumin sucks fluid out of the interstitium**

**Follow @defineshock 🩺 for more
evidence-based physiologic breakdowns**